In adults, what is the relationship between the intake of vegetables and fruits, not including juice, and type 2 diabetes?

Conclusion

Limited and inconsistent evidence suggests an inverse association between total vegetable and fruit consumption and the development of type 2 diabetes.

Grade: Limited

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

Evidence Summary Overview

In a review of five articles describing prospective cohort studies published since 2004, the evidence is inconsistent but suggests an inverse association between the development of type 2 diabetes (T2D) and total vegetable and fruit consumption (Liu, 2004), a direct association with potato (french fry) consumption (Halton, 2006), and no significant (NS) effect of tomato-based products (Wang, 2006). Another study indicated that total vegetables as well as vegetable subgroups, but not fruit, may have a preventive effect (Villegas, 2008). Conversely, the Nurses' Health Study (Bazzano, 2008) indicated no association between T2D risk and total vegetable and fruit consumption, but total fruit and green leafy vegetables were inversely associated. The number of vegetable and fruit servings in these five studies ranged from about 2.5 servings to more than 10 servings per day and sample sizes were large in all five cohort studies ranging from 35,000 to 84,000 participants (Bazzano, 2008; Halton, 2006; Liu, 2004; Villegas, 2008; Wang, 2006). The effect size was variable ranging from a multivariate relative risk (RR) of 0.82 (Bazzano, 2008) to 1.04 (Wang, 2006) and 1.21 (Halton, 2006) when comparing lowest quintiles to highest quintiles. However, the evidence is insufficiently strong to draw firm conclusions.

Evidence Summary Paragraphs

Bazzano et al, 2008 (positive quality), a prospective cohort study (Nurses' Health Study) in the US, examined the association between fruit, vegetable and fruit juice intake and self-reported T2D. A total of 71,346 female registered nurses were included in the analysis; Food-frequency questionnaires (FFQs) were completed every four years. Over 18 years of follow-up, 4,529 cases of T2D were documented. There was no association between total fruit and vegetable intake in the adjusted models; however, intake of total fruit and green leafy vegetables were inversely associated with development of T2D. For an increase of three servings per day in whole fruit consumption, the multivariate-adjusted HR was 0.82 (95% CI: 0.72, 0.94) and for an increase of one serving per day of green leafy vegetables, the multivariate-adjusted HR was 0.91 (95% CI: 0.84, 0.98).

Halton et al, 2006 (positive quality), a prospective cohort study (Nurses' Health Study) in the US, examined the association between potato and french fry consumption and self-reported T2D. A total of 84,555 female registered nurses were included in the analysis; FFQs were completed every four years. Over 20 years of follow-up, 4,496 cases of T2D were documented. The multivariate RR of

T2D in a comparison between the highest and lowest quintiles (median = 0.63 vs. 0.07 servings per day) of potato intake was 1.14 (95% CI: 1.02, 1.26; P for trend = 0.009). The multivariate RR of T2D in a comparison between the highest and lowest quintiles (median = 0.14 vs. 0 servings per day) of french fry intake was 1.21 (95% CI: 1.09, 1.33; P for trend <0.0001). The association between potato consumption and risk of T2D was more pronounced in obese women.

Liu et al, 2004 (positive quality), a prospective cohort study (Women's Health Study) conducted in the US, evaluated the hypothesis that a high intake of fruits and vegetables protects against the incidence of T2D and explored whether specific subgroups of fruits and vegetables differentially affected diabetes risk. A total of 38,018 female health professionals completed a FFQ at baseline and were included in the analysis. During an average of 8.8 years of follow-up, 1,614 self-reported cases of T2D were documented. Median intake of total fruits and vegetables ranged from 2.5 servings per day in the lowest quintile to more than 10 servings per day in the highest quintile. In models adjusted for age, totalcalories and smoking, significant inverse relationships were observed with diabetes risk for total fruit and vegetable intake, fruits, citrus fruits, green leafy vegetables and dark yellow vegetables and a significant positive association with intake of potatoes. However, after adjusting for known diabetes risk factors, none of these associations remained statistically significant. When stratified by body mass index (BMI) (less than 25 and 25kg/m^2 or more), no significant (NS) findings were observed in the lower BMI group. Among women with BMI higher than 25kg/m2, higher intake of green leafy or dark yellow vegetables was significantly associated with reduced risk of T2D (P for trend = 0.02 for both). However, after fully adjusting for BMI, the inverse associations of green leafy and dark yellow vegetables were still observed among overweight women, although the trends were not statistically significant.

Wang et al, 2006 (positive quality), a prospective cohort study (Women's Health Study) conducted in the US, examined the association between intake of lycopene and tomato-based products and the development of T2D. A total of 35,783 women were included in the analyses. During a median follow-up of 10.2 years, 1,544 self-reported cases of T2D were documented. Average (SD) intake of tomato-based food products was 4.33 (3.22) servings per week. Women who consumed more tomato-based food products had neither significantly decreased nor increased risk of T2D. Compared with women who consumed less than 1.5 servings per week of tomato-based foods, women who consumed 10 or more servings per week had a multivariateRR of 1.04 (95% CI: 0.80, 1.36; P for trend = 0.54).

Villegas et al, 2008 (positive quality), a prospective cohort study (Shanghai Women's Health Study) examined the association between fruit and vegetable intake and the self-reported incidence of T2D in 64,191 Chinese women. During 4.6 years of follow-up, 1,608 cases of T2D were documented. Median intake of fruits was 239.4g per day and median intake of vegetables was 236.0g per day. Quintiles of vegetable intake and T2D were inversely associated; in multivariate analyses, the RR for T2D for the upper quintile (428.0g per day) relative to the lowest quintile (121.5g per day) of vegetable intake was 0.72 (95% CI: 0.61, 0.85; P<0.001). Individual vegetable subgroups (cruciferous, green leafy, yellow, allium, tomatoes and other) were all significantly, inversely associated with risk of T2D. Fruit intake was not associated with the incidence of T2D.

Study	Study Type	Association: Pos, Neg, None
Bazzano et al, 2008 **Quality rating:**	**Prospective cohort study Nurses' Health Study, US**	**T2D: Ø vegetable and fruit; (-) fruit; (-) green leafy vegetables**
Halton et al, 2006 **Quality rating:**	**Prospective cohort study Nurses' Health Study, US**	**T2D: (+) potato, (+) potato french fries**

Liu et al, 2004 **Quality rating:**	**Prospective cohort study Women's Health Study, US**	**T2D: Ø vegetable, Ø fruit, Ø subgroups in fully adjusted models**
Wang et al, 2006 **Quality rating:**	**Prospective cohort study Women's Health Study, US**	**T2D: Ø tomato-based products**
Villegas et al, 2008 **Quality rating:**	**Prospective cohort study Shanghai Women's Health Study, China**	**T2D: (-) vegetable, Ø fruit, (-) with each vegetable subgroup (cruciferous, green leafy, yellow, allium, tomatoes and other)**

Research Design and Implementation Rating Summary

For a summary of the Research Design and Implementation Rating results, click here.

Worksheets

Bazzano LA, Li TY, Joshipura KJ, Hu FB. Intake of fruit, vegetables, and fruit juices and risk of diabetes in women. *Diabetes Care* 2008;(31)7:1311-1317.

Halton TL, Willett WC, Liu S, Manson JE, Stampfer MJ, Hu FB. Potato and french fry consumption and risk of type 2 diabetes in women. *Am J Clin Nutr.* 2006;83(2):284-90.

Liu S, Serdula M, Janket SJ, Cook NR, Sesso HD, Willett WC, Manson JE, Buring JE. A prospective study of fruit and vegetable intake and the risk of type 2 diabetes in women. *Diabetes Care.* 2004 Dec;27(12):2993-6.

Villegas R, Shu XO, Gao YT, Yang G, Elasy T, Li H, Zheng W. Vegetable but not fruit consumption reduces the risk of type 2 diabetes in Chinese women. *J Nutr.* 2008 Mar;138(3):574-80.

Wang L, Liu S, Manson JE, Gaziano JM, Buring JE, Sesso HD. The consumption of lycopene and tomato-based food products is not associated with the risk of type 2 diabetes in women. *J Nutr.* 2006 Mar;136(3):620-5.